

PROJECT DATA

Powdermet, Inc. - 03GO13012

Oxide Dispersion Strengthened Iron Aluminide by CVD Coated Powder

<p>Recipient: Powdermet, Inc.</p> <p>Recipient Project Director: Asit Biswas 216.404.0053 x-108 24112 Rockwell Drive Euclid, OH 44117</p> <p>Recipient Type: For-Profit Organization</p> <p>Subcontractor(s):</p> <p>EERE Program: Industrial Technologies</p>	<p>Instrument Number: DE-FG36-03GO13012</p> <p>CPS Number: 2356</p> <p>HQ Program Manager: Lisa Barnett 202.586.2212</p> <p>GO Project Officer: Gibson Asuquo 303.275.4910</p> <p>GO Contract Specialist: Melissa Wise 303.275.4907</p> <p>B&R Number(s): ED1906020</p> <p>PES Number(s): 03-10065, 04-10011</p> <p>State Congressional District: OH - 26</p>
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PROJECT SCOPE: Powdermet will reduce to practice, a revolutionary new Vapor Phase Synthesis of Nanoengineered Particles (VPSNP) manufacturing process to enable cost-efficient production of materials with designer structures controlled on a nanometer scale. Powdermet will then develop and demonstrate an innovative “powder friction forming” thermal spray process for applying iron aluminide (and other) coatings to alternate substrates and develop fabrication processes for boiler tube and hot gas filter structures.

FINANCIAL ASSISTANCE

Approved DOE Budget:	\$199,750	Approved DOE Share:	\$199,750
Obligated DOE Funds:	\$99,875	Cost Share:	\$0
Remaining Obligation:	\$99,875		
Unpaid Balance:	\$21,307	TOTAL PROJECT:	\$199,750

Project Period: 05/01/03 - 05/01/05

TECHNICAL PERFORMANCE

DE-FG36-03GO13012

Powdermet, Inc.

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PROJECT SYNOPSIS

Powdermet will reduce to practice, a revolutionary new Vapor Phase Synthesis of Nanoengineered Particles (VPSNP) manufacturing process to enable cost-efficient production of materials with designer structures controlled on a nanometer scale. They will optimize the properties and performance of iron aluminide alloys (forgings and mill product) having between 16 and 38wt% aluminum by developing an understanding of nanoengineered particle design-processing-microstructure-performance relationships. Powdermet will then develop and demonstrate an innovative "powder friction forming" thermal spray process for applying iron aluminide (and other) coatings to alternate substrates and develop fabrication processes for boiler tube and hot gas filter structures. The final goal of the project is to demonstrate alloy and component suitability through laboratory (Foster-Wheeler) simulated flue gas corrosion testing, and through component sub-element insertion into operating combustion and hot gas cleanup systems to begin accumulating field service data.

SUMMARY OF TECHNICAL PROGRESS

Powdermet made an attempt to coat 1-5 micron size iron powders with aluminum using chemical vapor deposition (CVD) of Tri-Ethylene Aluminum (TEAL). Problems were encountered with agglomeration, as particles are agglomerated in the riser part of the reactor. Powdermet has begun work to modify their gas flow parameters and control the vaporizer temperature to alleviate these problems. They have also worked to develop iron/aluminum coated alumina thermal sprayable powders for low CTE iron aluminide coating development and composites.

Alloyed powders were consolidated by extrusion to study the oxide dispersoid size and distribution. Powders were cold isostatic pressed and extruded. For extrusion, the CIP cylinders were encapsulated in mild-steel cans, containing a solid nose and open at one end for insertion of the CIP cylinder. The open end was sealed with a plug containing a vent tube. TEM micrograph studies revealed that the dispersoid size averages 100-150 microns instead of the desired 10 nanometer size. Further work will be required to reduce the dispersoid size and distribution.

In line with large scale aluminum coating and commercialization, Powdermet has worked on improving aluminum alkyl safety and handling, process refinement to enable single-run coating to be accomplished (thereby lowering the cost, handling, and intermediate passivation/oxygen exposure of the aluminum), nucleation enhancement (obtaining smoother coatings at lower volume percent aluminum), and alternatives to oxidation for passivating the aluminum and preventing moisture adsorption.

Powdermet's commercialization efforts are focused on understanding the main drivers that determine a successful commercialization of oxide-dispersant-strengthened (ODS) intermetallics, particularly in applications that target the energy industry. Their strategy is to leverage the commercialization expertise that was acquired during the early commercialization activities of nickel aluminides and thereby to hasten the market introduction of ODS alloys.

SUMMARY OF PLANNED WORK

Powdermet will continue to modify their gas flow parameters and control the vaporizer temperature to alleviate the problems encountered in the last quarter. They will also continue to develop safe handling and safety related to the large volume of pyrophoric metal alkyls. Powdermet will continue to look for commercialization partners with the help of New Horizon Technology.

PROJECT ANALYSIS

The project is on schedule and on budget. No obstacles are seen in the immediate future.

ACTION REQUIRED BY DOE HEADQUARTERS

No action is required from DOE Headquarters at this time.

STATEMENT OF WORK

DE-FG36-03GO13012

Powdermet

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Detailed Task Description

Task 1. Processes Development

Refine aluminum, iron and oxide deposition processes to enable controlled, nanometer-scale coatings to be applied to various core particles. Benchtop development shall be conducted and then translated to fine particles in Powdermet's RFFB reactor system. Specifically, the program will explore the Fe-Al-Cr-Mo-B alloying system. Iron will be deposited by iron carbonyl, aluminum by TIBAL, aluminum oxide by aluminum-isopropoxide, molybdenum by molybdenum carbonyl, chromium by chromium carbonyl and boron by di-borane.

Task 2. Nanoengineered Particle Design

A finite element model shall be developed for geometric changes occurring in the particles during consolidation and mechanical deformation. The MAP_STEEL_PM2000 source code will be modified to predict controlling mechanisms in ODS iron aluminide as functions of dispersoid size and spacing. Geometric and mechanical modeling combined with Phase I results will be used to generate up to 70 particle designs for fabrication.

Task 3. VPSNP Particle Design

10-50 lbs. each of up to 25 nanoengineered alloyed iron aluminide particle designs will be fabricated using Powdermet's Recirculating Fast Fluidized bed (RFFB) pilot plant reactor.

Task 4. Process Development and Refinement

CIP/extrude, CIP/sinter/powder forging and reactive sintering consolidation processes shall be used to produce dense samples. Extrusion will be conducted by Huntington Alloys and forging will be conducted by Ceracon Inc.

Task 5. Testing and Analysis

After heat treatment (1150° C/air cooling) mechanical properties, microstructures, oxidation, corrosion and carbonization resistance will be screened for each of up to 50 material variants. Mechanical properties/TEM/SEM will be done at University of Cincinnati/Powdermet. Corrosion testing will be done at Foster Wheeler Corporation.

Task 6. Downselection

Four materials will be downselected from Task 5 results for further study, and will be subjected to simulated flue gas exposures at Foster Wheeler and detailed mechanical property characterization. Sub-element coupons will be placed in actual coal-fired power plants (based on maintenance schedules) and exposed for extended periods.

Task 7. Extrusion/Pipe Production

Extrusion Procedures for producing 1/8" wall, 2" diameter seamless iron aluminide tubing will be developed and approximately 50 ft. of tubing will be produced at Ames Laboratory.

Task 8. Developing Filers/Testing

Processes for manufacturing controlled porosity, high efficiency filter elements will be developed and 20" long by 1 3/4"-diameter minicandle filters will be fabricated and tested in steam environments. Permeability, strength and filtration efficiency shall be measured.

Task 9. Developing Thermal Spray Coatings

The powder friction forming process will be developed to apply iron aluminide coatings to stainless steel and inconel substrates and to boiler tubing. Thermal spray process will be developed at Plasma Process Technology, Torrance, CA.

Task 10. Pipe Fabrication

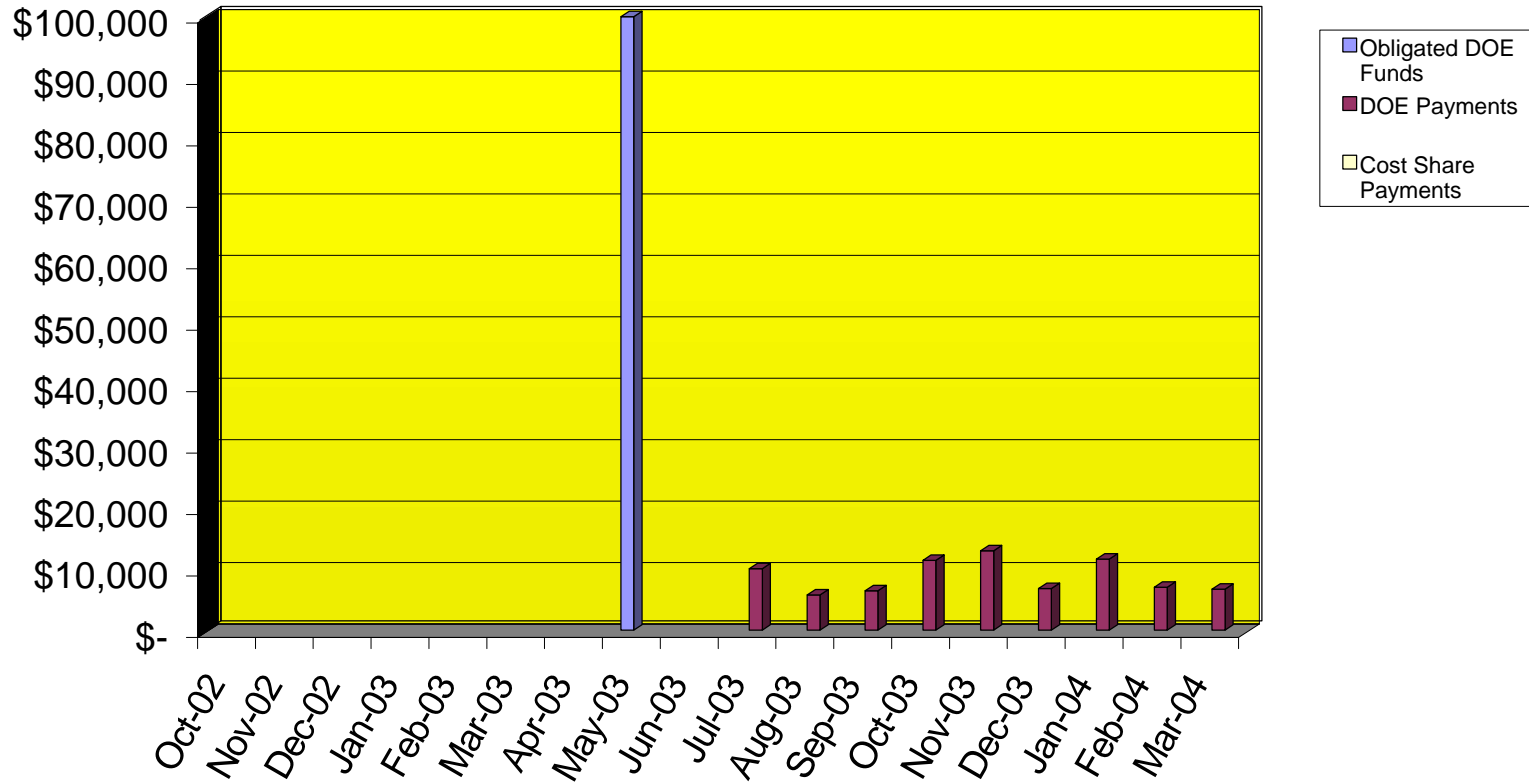
Bending and attachment procedures for iron aluminides will be evaluated at Nooter Co. to define fabrication procedures for boiler components.

Task 11. Project Management & Reporting

Powdermet, Inc. is responsible for submitting both Semi-Annual Progress Reports and a Final Report to DOE. The Semi-Annual Reports are due every April 30 and October 31. The Final Report is due 90 days after the project completion date as specified in the agreement. This task also includes other DOE requirements for market assessments, fact sheets, benefits analyses, workshops, etc.

Project Cost Performance in DOE Dollars for Fiscal Year 2003

DE-FG36-03GO13012 Powdermet, Inc.
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	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03
Obligated DOE Funds	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$99,875	\$0	\$0	\$0	\$0
DOE Payment	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$10,000	\$5,770	\$6,428
Cost Share Payment	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0

	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	PFY*	Cumulative
Obligated DOE Funds	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$99,875
DOE Payment	\$11,361	\$12,961	\$6,811	\$11,570	\$6,981	\$6,686	\$0	\$78,568
Cost Share Payment	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0

Approved DOE Budget:	\$199,750
Approved Cost Share Budget:	\$0
Total Project Budget:	\$199,750

* Prior Fiscal Years

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